





Bringing Internet Video to Prime Time

Aditya Ganjam  
Vice President of Engineering  
Conviva

### Background

- Aditya Ganjam – Vice President of Engineering at Conviva
- Conviva
  - Startup founded by Hui Zhang (Prof. at CMU) and Ion Stoica in 2006
  - Conviva optimizes video quality for premium content properties such as HBO, ESPN, ABC, Disney, and Turner through network wide real-time visibility and real-time actions. Conviva's technology has powered some of the world's largest on-line events such as Olympics, FIFA World Cup, NCAA College Basketball March Madness, Major League Baseball, and Academy Awards.

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### 2005: Beginning of the Internet Video Era



Launch of YouTube  
100M streams first year



First popular mobile video device




Premium Sports Webcast on Line



Live8 concert online

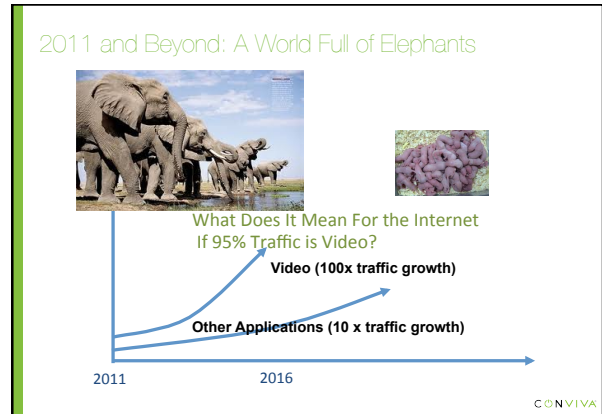
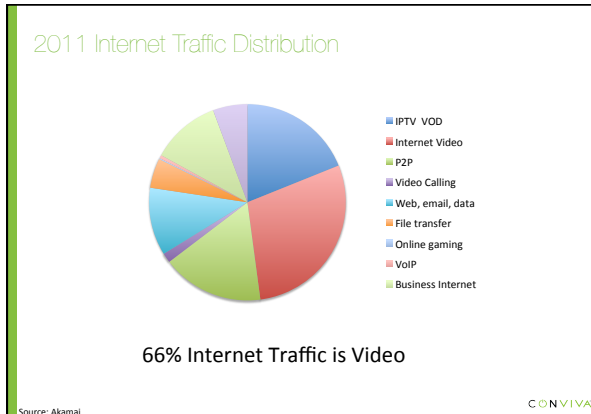
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### 2006 – 2011: Internet Video Going Prime Time



2006 2007 2008 2009 2010 2011

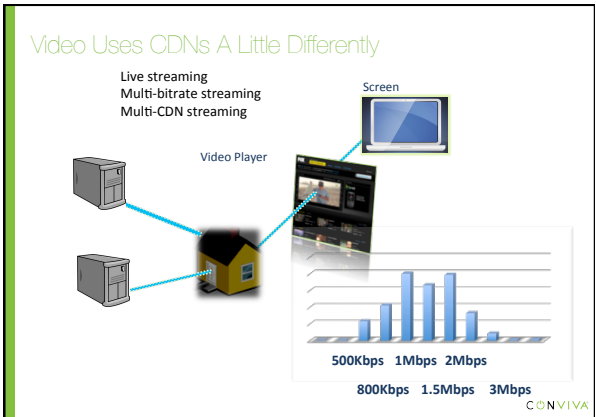
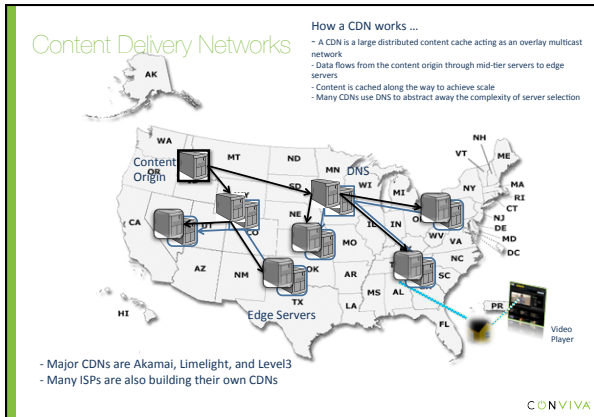
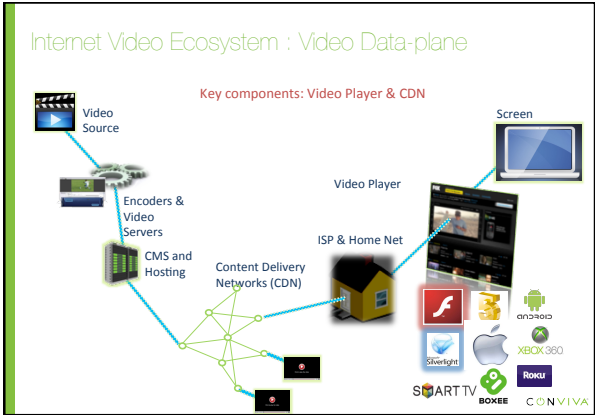
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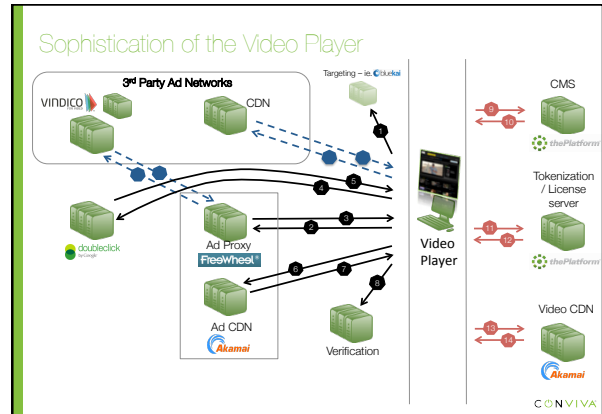


- ### Macro Changes in Internet Video Technology and Business
- o Technology enablers in place
    - o Broadband penetration
    - o Standard software & hardware platforms
  - o Real business model emerging
    - o Premium content (ESPN, HBO)
    - o Advertising & subscription (mib.com, netflix, Hulu)
  - o Online audiences rival broadcast for major events
    - o Olympics, Inauguration, Michael Jackson, World Cup
  - o Convergence of TV, Internet, Mobile
    - o Internet connected TVs (Xbox, Playstation, AppleTV, Roku, Sony, Samsung)
    - o Internet connected smart mobile devices (iPad, iPhone, Android)
    - o "TV Everywhere" over the top (HBO, ESPN, Turner, Comcast)
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- ### This Talk
- o Delivering high quality video over the Internet and Conviva's approach to addressing this challenge
  - o Three sections ...
    - o Understanding today's Internet video eco-system
    - o State of the art of Internet video quality
    - o A strategy for delivering high quality video
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# Understanding Today's Internet Video Eco-system

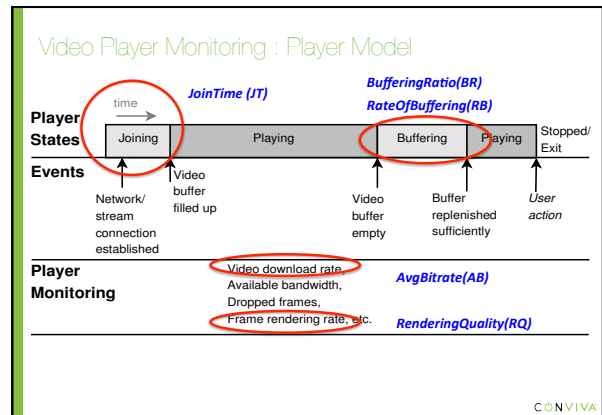




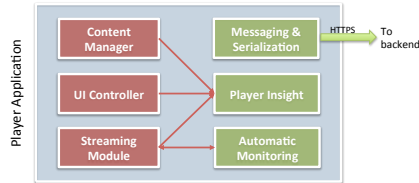
### What is the quality of Internet video today ?

- What is high video quality?
  - Prevent video startup failures
  - Start the video quickly
  - Play the video smoothly and without interruptions
  - Play the video at the highest bit rate possible
- What is the best way to measure Internet video quality?
  - Claim:** Collecting statistics from the video player is the best way to measure video quality
    - Reason 1:** The video player interacts with multiple services owned by multiple companies and is the only single point that has state across all interactions
    - Reason 2:** With multi-bit rate and multi-CDN technologies, a single server or CDN does not have the complete quality information for a client

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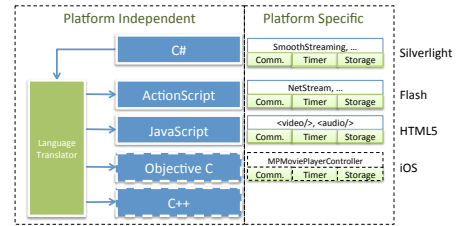
### Video Player Monitoring : Data Collection



- Automatic and consistent monitoring of default streaming modules
  - Flash: NetStream, VideoElement
  - Silverlight: MediaElement, SmoothStreamingMediaElement
  - iOS: MPMoviePlayerController

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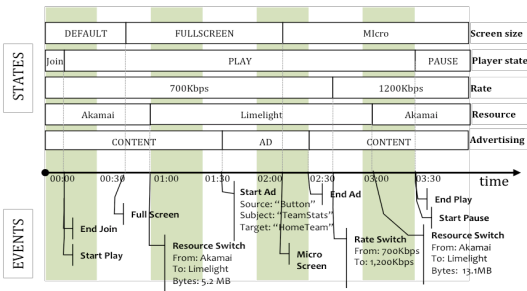
### Video Player Monitoring : Cross-platform Challenges



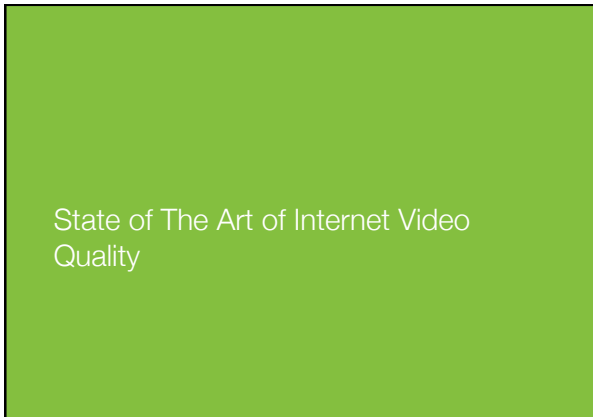
- Consistency in metric computation across languages and platforms
- Benefit from stronger type checking from C#
- Readable output: preserve comments, white space, formatting
- Provides control for language-specific fragments
- Compiles real code and unit tests
- Uniform tracing and debugging

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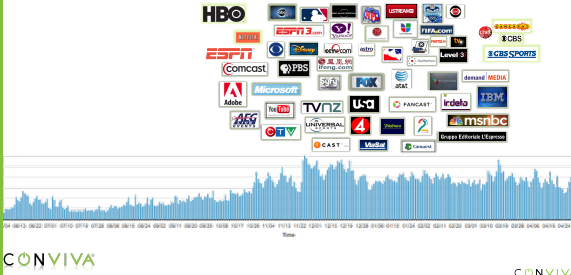
### Video Player Monitoring : Data Model



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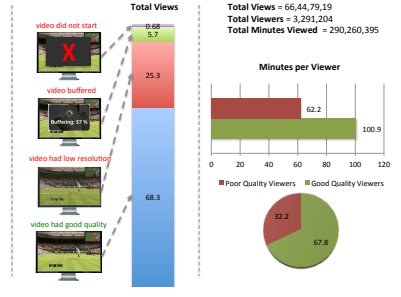


We've seen patterns across many sites ... and billions of streams



### Example Video Site Quality Summary

- 31.68% of views had quality issues
- 32.2% of viewers had recurring quality issues
- Viewers with good quality watched 1.5X more video than viewers with poor quality
- Good video quality for all viewers can add 10.9% more minutes of viewed video
- Good video quality can add \$120K more revenue per month\*

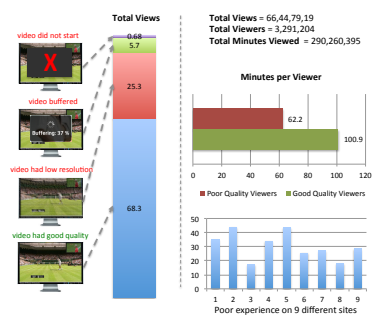


\* Assumes \$30 CPM ad every 8 minutes

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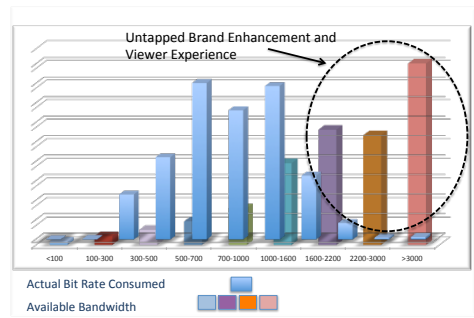
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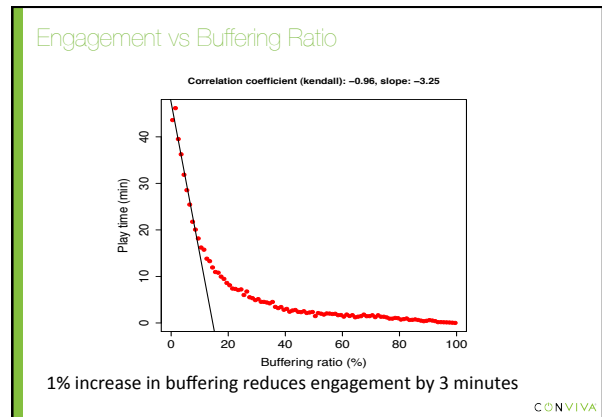
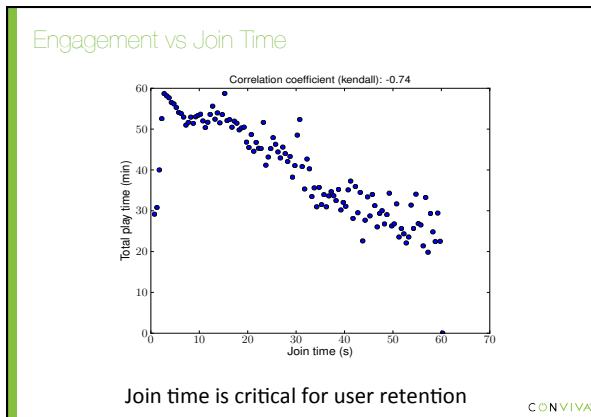
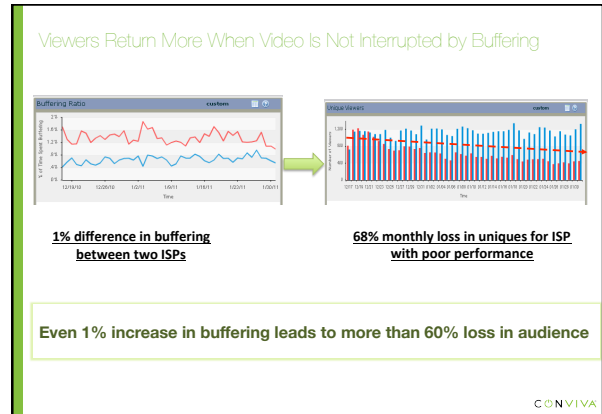
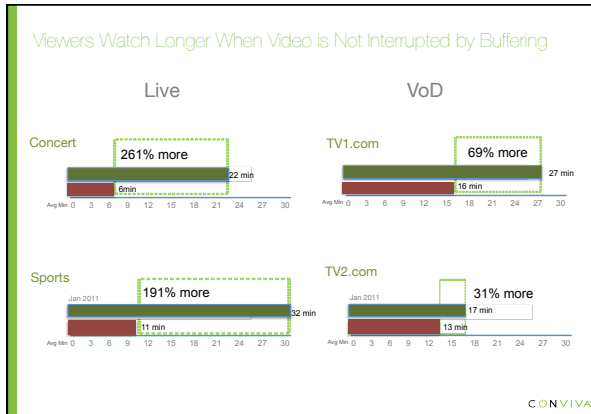
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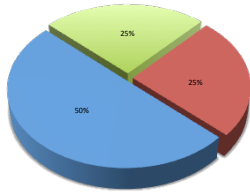
### Opportunity of Going Higher Speed



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CDNs Vary in Performance over Geographies and Time

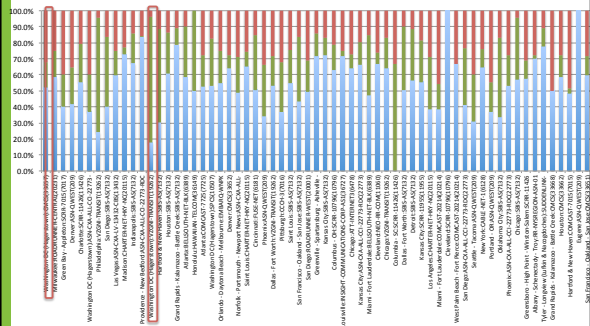


- Used one month aggregated data-set
- Considered 31,744 DMA-ASN-hours with > 100 views in each CDN

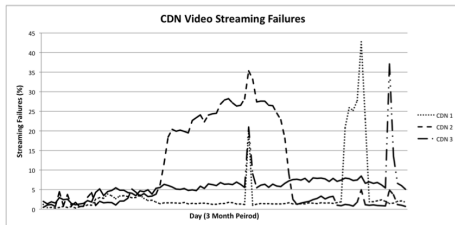
There is no single best CDN across geographies, networks, and time



CDNs Vary in Performance over Geographies and Time



CDN Streaming Failures Are Common Events



Summary of Results

- On most sites 15-30% of viewers do not get an uninterrupted high quality stream
- Quality has a substantial impact on viewer engagement
  - Buffering ratio is most critical across genres (for live event: 1% increase in buffering reduces 3min play time)
  - Join time impacts engagement at viewer level
- CDN performance varies minute by minute and region by region





## A Strategy for Delivering High Quality Video Over the Internet

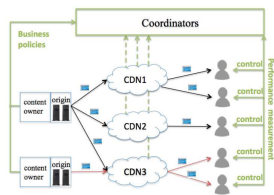
### Refresh: What is high quality?

- Prevent startup failures
- Start the video quickly
- Play the video smoothly and without interruptions
- Play the video at the highest bit rate possible

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### Three Concepts for High Quality Video Delivery

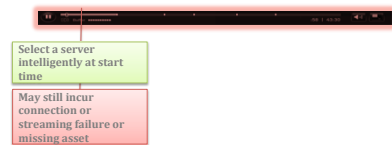
- Continuous measurement and optimization using a control infrastructure decoupled from the delivery infrastructure
- Multi-bit rate streams delivered using multiple CDNs
- Optimization algorithms based on individual client and aggregate statistics working at multiple time scales



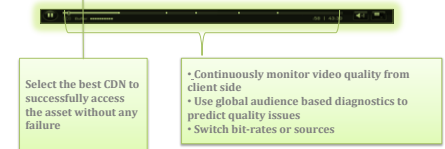
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### One-time DNS Re-direction vs Continuous Optimization

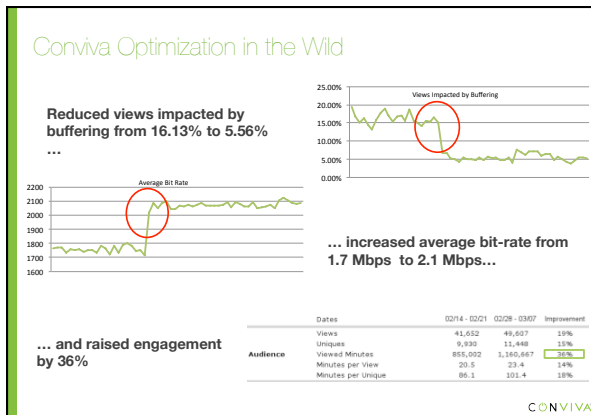
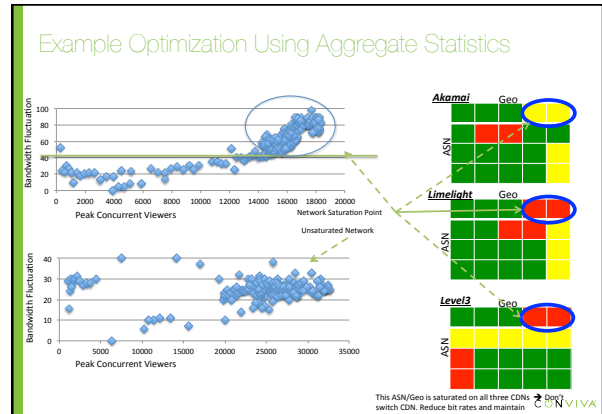
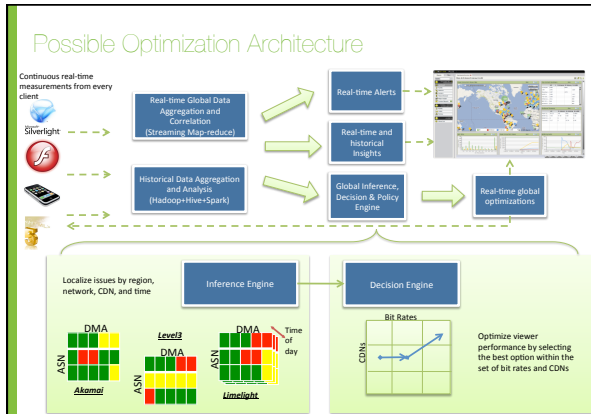
#### CDN



#### Continuous optimization



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- ### Concluding Remarks
- All indications show that we are in the middle of a key transition of main-stream video to the Internet
  - Video quality presents opportunity and challenge
    - Follow the traffic: 60% Internet traffic today, will be more than 95% in the next 2-3 years
    - Premium video will be consumed by lean-back experience on big screens → zero tolerance for poor quality
  - Video player continuous monitoring and optimization driven by player-level and global algorithms has the best chance of delivering high quality video